Title: Show Me the Volume!

Brief Overview:

In this learning unit the student will predict the formula for the volume of a pyramid by visually exploring the contents of a pyramid and a cube. The student will then test his/her formula by measuring the contents of the pyramid and cube. Once the student comes up with the correct formula, he/she will compile the actual dimensions of several pyramids by using an Internet site and then compute the volumes of the respective pyramids.

Links to NCTM 2000 Standards:

- **Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation**
  These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

  Students will demonstrate their ability to solve problems with a connected application in a cooperative environment with the use of technology. They will demonstrate their ability to reason mathematically by making conjectures, gathering evidence, and testing their formulas. Furthermore, students will demonstrate their ability to represent their mathematical ideas physically, visually, and numerically.

- **Number and Operation**
  Students will demonstrate their ability to identify relationships among numbers and to apply their estimation skills.

- **Patterns, Functions and Algebra**
  Students will demonstrate their ability to use symbolic forms to represent and analyze mathematical situations.

- **Geometry and Spatial Sense**
  Students will demonstrate their ability to analyze geometric properties of pyramids and use visualization and spatial reasoning to solve problems.

- **Measurement**
  Students will demonstrate their ability to apply concepts of volume using a graduated cylinder.

Links to National Science Education Standards:

- **Science as Inquiry**
  Students will use the graduated cylinder to test their formulas.

Grade/Level:

Grade 7

Duration/Length:

This lesson will take 2-3 class periods.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Calculating the volume of a cube
- Using graduated cylinders for measurement
- Using the Internet to gather information

Student Outcomes:

Students will:

- estimate the volume of a pyramid.
- determine and apply the formula for the volume of a pyramid.
- work cooperatively in groups.
- communicate effectively their findings.

Materials/Resources/Printed Materials:

For each cooperative group:

- Scissors
- Templates A, B, and C posted on tag board in advance
- Rulers
- Funnels
- Scoops
- Bird seed
- Packing tape
- Worksheets 1 and 2
- Internet access
- Calculator
- Two graduated cylinders, labeled A and B
- Colleague (or teacher's assistant)

Development/Procedures:

Pre-Day 1 Homework:

- Journal Entry - Compare and contrast the concepts of area and volume. Refer to two objects in your home that will help to illustrate your opinion.

Day 1:

- Ask students to share their responses to the journal entry topic.
- Distribute templates, scissors, tape, bird seed, and two graduated cylinders to students in three groups of students (A, B, and C). Note that the 3 different templates contain cubes and pyramids with different dimensions and each group should get template A, B, or C.
- Students should fold and tape edges of templates to form a cube and a pyramid.
- Complete questions 1-8 on Worksheet 1. **Caution: Students may need a little help going from "volume of a cube" to "volume of a pyramid".**
- Stop group work. Collect and write data from each group on the board using the chart in question 9 on Worksheet 1.
- Resume group work - have students answer question 10 through 12.

Day 2:

- Make brief comments about the connection between yesterday's activity and today's activity.
- Distribute Worksheet 2 and have students work together in groups (A, B, or C) to answer questions 1 through 3. **Teacher should verify the website and decide which dimensions to jot down**.
- Facilitate discussion of students' findings and approaches to question 3.
- Students must complete question 4 for homework.

Performance Assessment:

Students must turn in the two worksheets. Teacher will evaluate their work according to the following rubric.

Response Levels:

3 - All calculations are accurate. Student shows a mastery of the language of math to communicate mathematical ideas, processes, and concepts. The student's written responses must demonstrate clear and logical thinking.

2 - Some calculations are accurate. Student can communicate mathematical ideas, processes, and concepts, but is limited in his/her use of math terminology. Student's writing lacks cohesiveness but is reasonable.

1 - None of the calculations are accurate but effort was shown. Student demonstrates a fragmented understanding of the knowledge and skills needed to complete the task. Student communication of mathematical ideas, processes, and concepts is vague.

Extension/Follow Up:

- Using the Internet website from Worksheet 2, compare current dimensions of pyramids with original dimensions. Explore what factors could account for the differences in dimensions (e.g., erosion).
- Use the dimensions of pyramids to create a model to scale. Be sure that students employ proportions properly.
- Use this lesson to introduce the Pythagorean Theorem. For instance, teacher may ask students to figure out the surface area of each face of a given pyramid.

Authors:

Pamela A. Dooley
The Newport School
Montgomery County, MD

Anders Alicea
The Newport School
Montgomery County, MD

Jennifer Walko
Westminster East Middle School
Carroll County, MD

Robinson Nwosu
Argyle Middle School
Montgomery County, MD

Name: _____
Date: _____

Exploring the Volume of a Pyramid
Student Worksheet 1 (Page 1)

You'll need:

- Templates, scissors, tape
- Bird seed
- Two graduated cylinders
- Scoops, funnels, rulers
- Colleague (or teacher's assistant)

Instructions:

1. Cut out the cube and pyramid templates on handouts A, B, or C and construct both figures with tape.

2. Using the given materials, how could you figure out how to find the formula for calculating the volume of the pyramid?

_____

_____

_____

_____

3. Estimate how many pyramids-full of bird seed it will take to fill the cube completely.

_____

_____

4. Fill the pyramid with bird seed and pour it into the cube <u>one time</u>. Carefully examine your cube, which now contains one pyramid-full of bird seed.

5. Would you now like to change your estimate of how many pyramids-full of bird seed it will take to fill the cube completely? If so, what do you want to change it to?

_____

_____

6. Continue filling the cube using the pyramid until the cube is completely filled with bird seed, counting how many full pyramids you used. How many pyramids did it take to fill the cube?

_____

_____

7. Measure the lengths of the bases and the heights for each figure and record them in the chart below. Then, calculate the areas for each base. Round your measurements to the nearest centimeter (cm).

	Length of base (cm)	Area of base	Height (cm)
Cube	_____	_____	_____
Pyramid	_____	_____	_____

8. Knowing that the volume of a cube can be found by multiplying the area of the base by the height, compare the volume of your cube and the volume of your pyramid.

The volume of my cube is: _____

The volume of my pyramid is : _____

9.

	Volume of cube	Volume of pyramid
Group A	_____	_____
Group B	_____	_____
Group C	_____	_____

10. Looking at all of the group's results, write what you believe is the formula for the volume of a pyramid.

_____

11. Using the bird seed, pyramid, cube, and graduated cylinders A and B, how could you verify that your formula is correct? Describe the process and your results.

_____

_____

_____

_____

12. Was your formula correct?

_____

Name: _____
Date: _____

Exploring the Volume of a Pyramid
Student Worksheet 2 (Page 1)

You'll need:
• Internet access
• Calculator

Instructions:

1. Today we will use the Internet to research the Pyramids of Giza and apply the formula for finding the volume of a pyramid. Remember, the formula is 1/3 x area of base x height. Go to the following website: *http://www.pbs.org/wgbh/nova/pyramid*. Once you access this website, double click on the 'Explore Pyramids' link.

2. Using this website, find the original length of the base (in feet) and calculate the area of the base. Then, find the original height (in feet) and calculate the volume of each pyramid.

Pyramid	Base Length	Area of Base	Height	Volume
Menkaure	_____	_____	_____	_____
Khufu	_____	_____	_____	_____
Khafre	_____	_____	_____	_____

3. Suppose that you were going to redesign one of the Pyramids of Giza. How would you be able to decrease the volume without changing the height?

_____

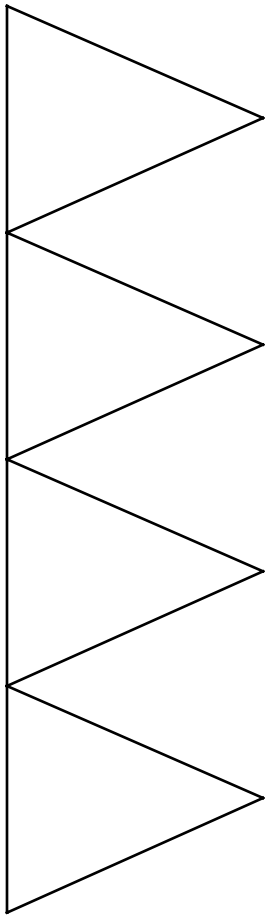
_____

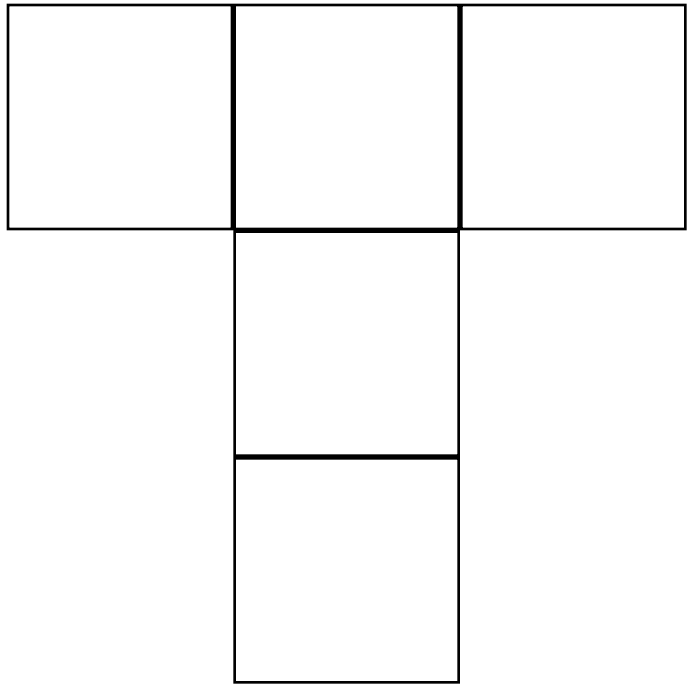
_____

Going Further

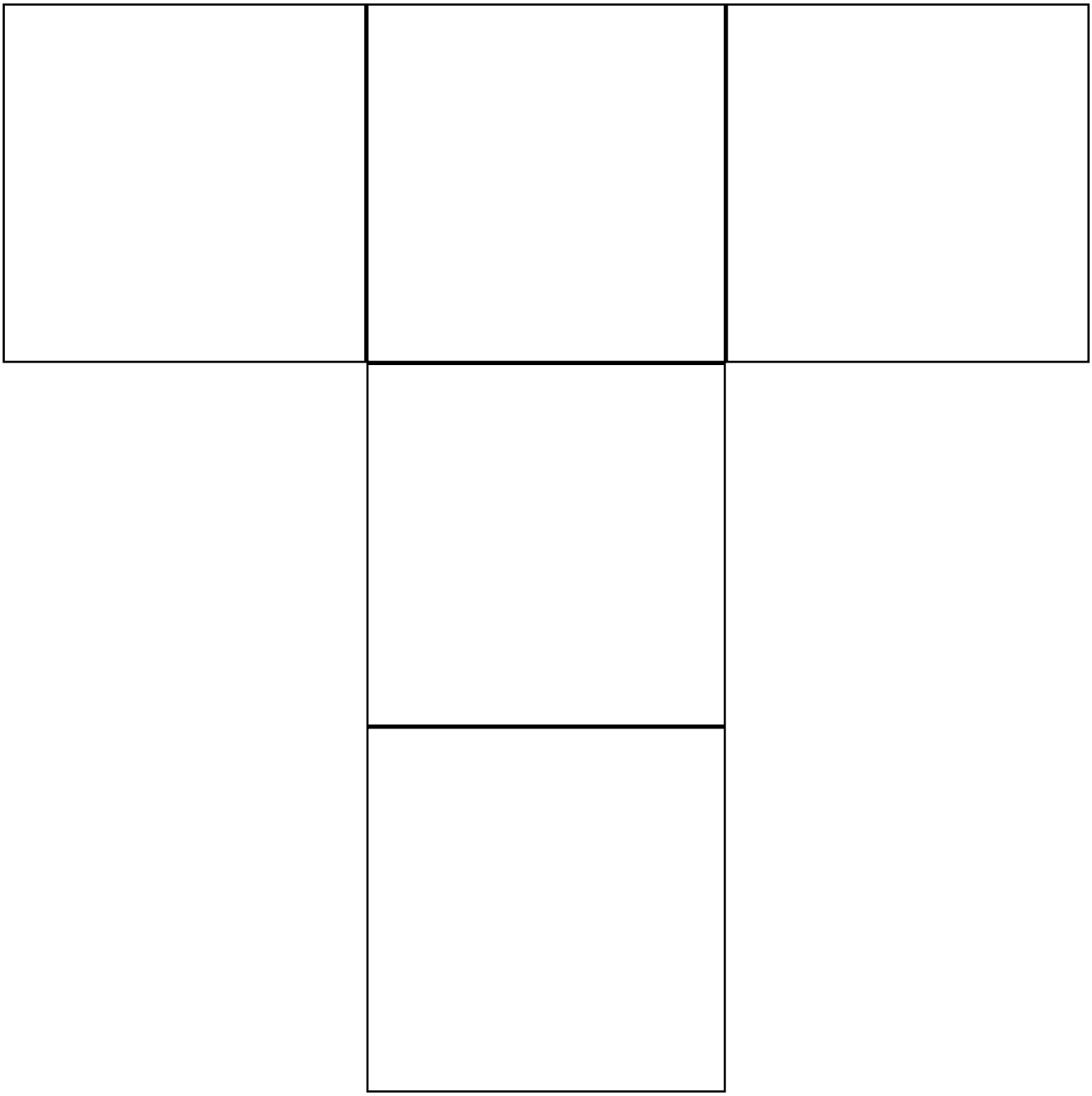
4. Imagine that the newest ice cream shop has a GIGANTICONE. It is the biggest sugar cone in Maryland! (a) How is the shape of this cone different from that of a pyramid? (b) Restate how we derived the formula for the volume of a pyramid. (c) Could we use the same procedure for determining the volume of a cone? Explain why or why not.

Group A Templates

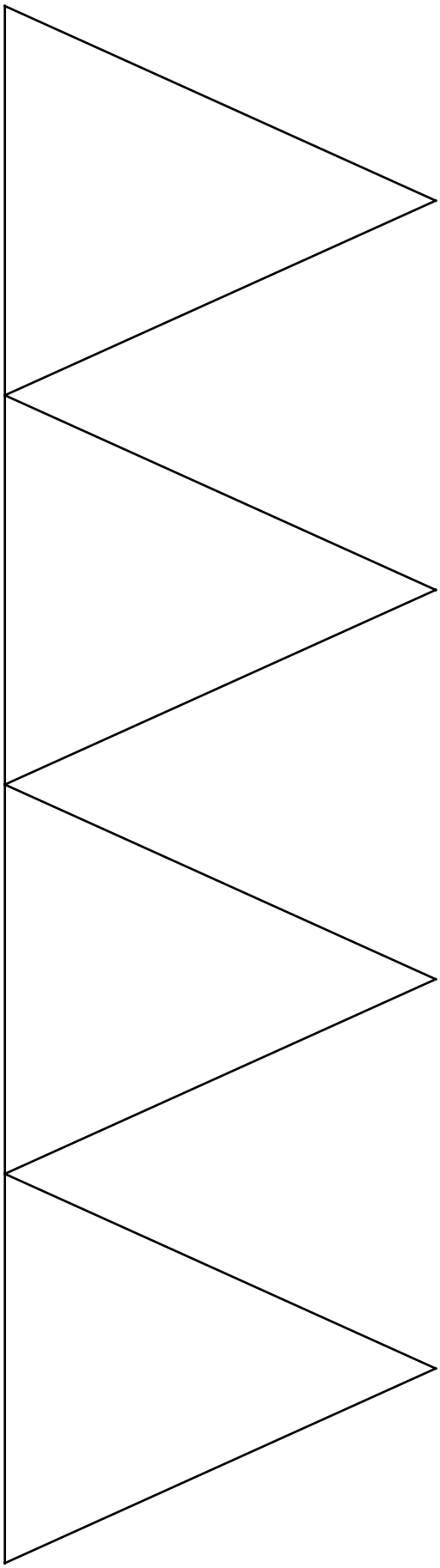




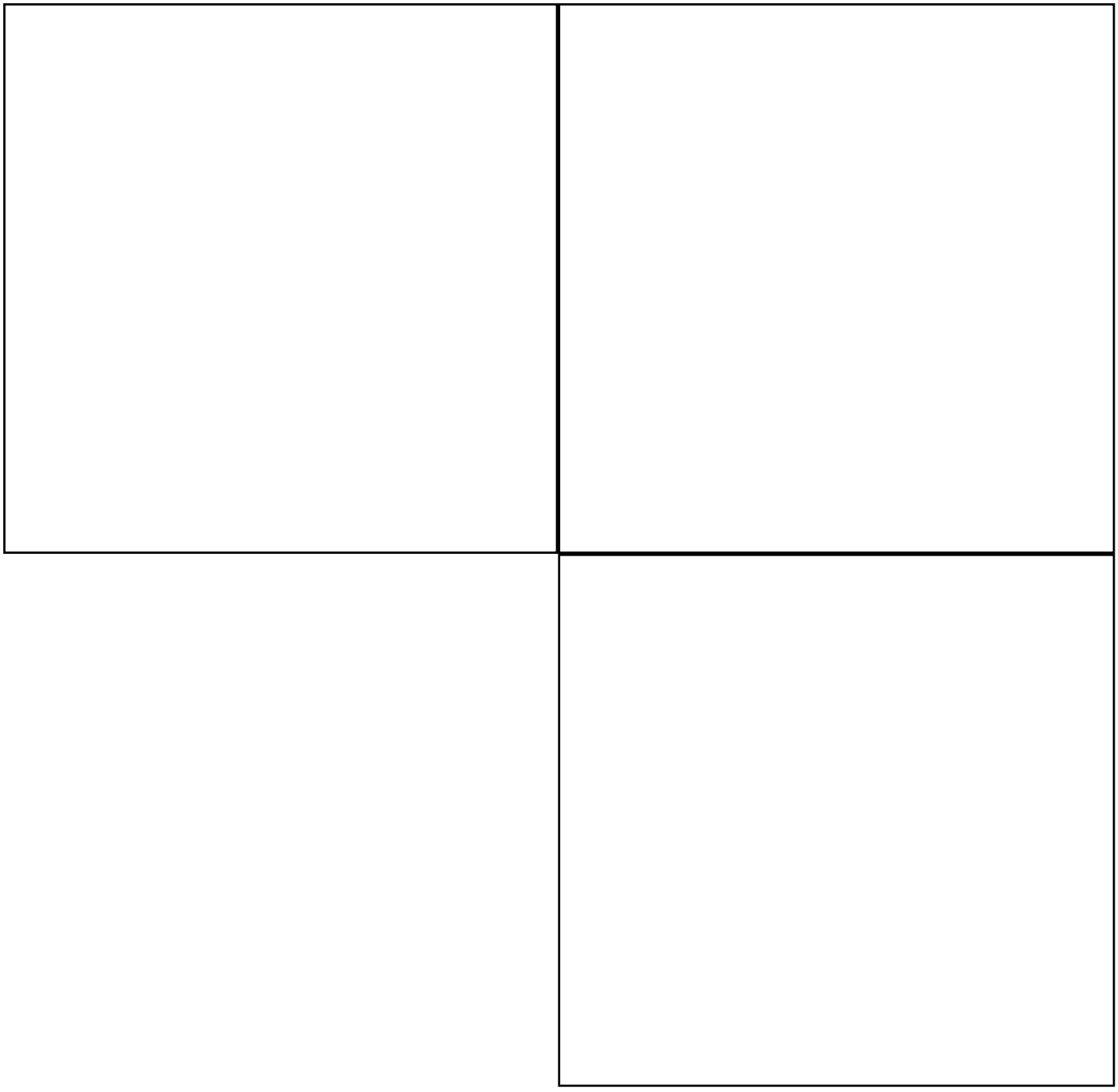
Group B Cube Template



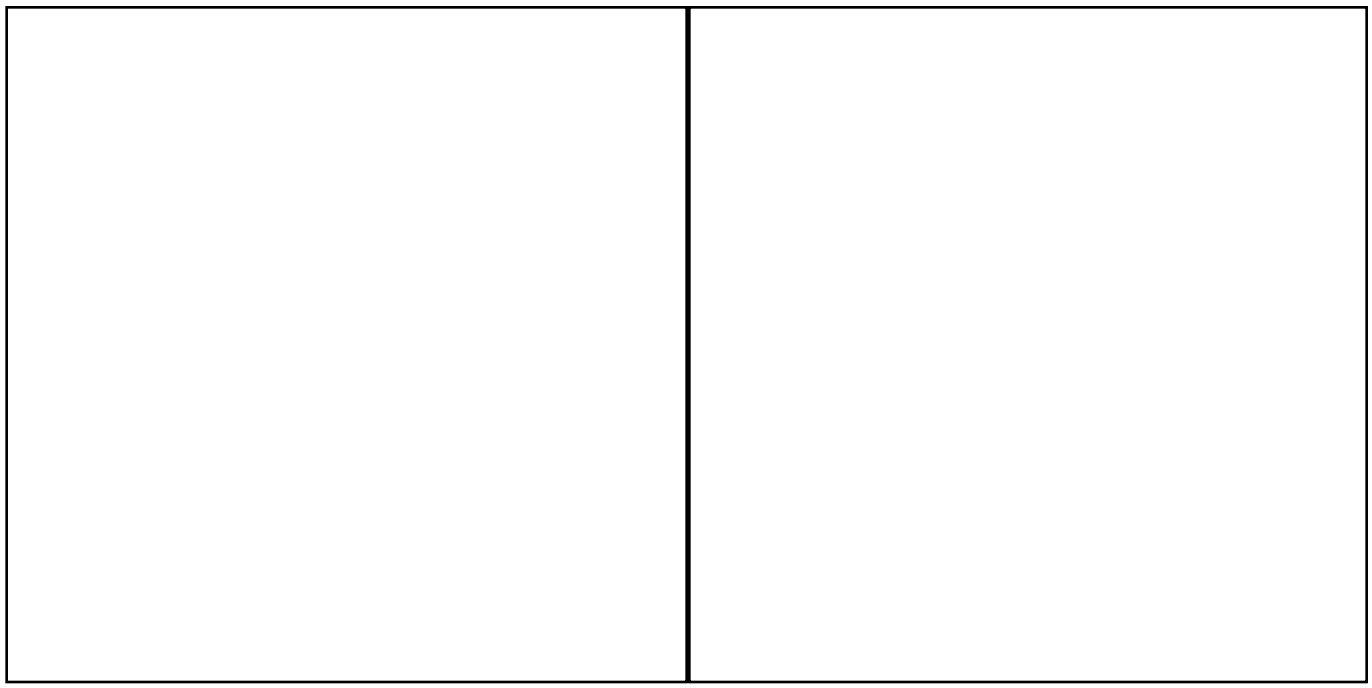
Group B Pyramid Template



Group C Cube Template (Page 1)



Group C Cube Template (Page 2)



Group C Pyramid Template